Bootrom solutions in computer lab management

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ABSTRACT

This study comprehensively evaluates modern Bootrom solutions based on three key criteria: (1) operational performance, (2) cost efficiency and (3) practical applicability within Vietnam's technological infrastructure. The research findings not only provide a holistic overview of Bootrom technology development trends but also propose optimized deployment models, particularly suitable for Vietnamese enterprises during the current digital transformation phase.

Bootrom has introduced a novel approach to computer system management by replacing traditional physical hard drives with an intelligent centralized storage mechanism. Through this technology, workstations can operate reliably using virtual disks managed centrally from a server, connected via local area networks or the internet.

Keywords: *Diskless Network Technology, Bootrom-based Systems, CSMBoot Platform, Network Infrastructure Management, IT Virtualization Solutions*

1. INTRODUCTION

Bootrom technology (or diskless computing systems) has marked a significant advancement in modern computer architecture. Research by Niu Bin et al. (2020) demonstrates that this technology operates through a centralized storage mechanism, where client machines boot and run via virtual disks managed by a central server [1]. According to findings by Niu Bin's team (2020), this model reduces hardware costs by up to 60% compared to the traditional systems [1].

Although introduced in the early 21st century, Bootrom technology only achieved breakthrough development from 2010 onward, primarily due to advancements in network infrastructure [2]. Our empirical study of 15 systems in Vietnam indicates this technology is particularly suitable for deployments of 50-250 client machines, delivering stable performance (latency < 50ms) and superior security (90% reduction in malware infection risks).

2. COMPARISON OF BOOTROM SOLUTIONS

Bootrom (diskless computing) technology is gaining popularity due to its ability to reduce hardware costs, save energy, and minimize virus risks. Currently, there are several Bootrom management solutions available, each with its own strengths and limitations. This article analyzes popular platforms such as NXD, CCBoot, Gcafe Diskless, and CSMBoot to help users make informed decisions [3].

Model 1: NXD is a bootrom solution developed by NetzoneSoft, offering notable advantages in stability and security. The system supports a multi-server backup mechanism, enabling automatic failover to secondary servers when the primary server encounters issues, ensuring uninterrupted operation. Another key strength is its Linux-based platform, which significantly reduces virus infection risks compared to Windows-based systems.

However, this solution also has some notable limitations. It is a commercial product

requiring licensing fees. Technically, NXD demands administrators to have in-depth Linux expertise, particularly in storage management commands. Currently, NXD lacks an official distributor in the Vietnamese market, meaning users must primarily rely on self-study and manual setup, posing challenges in real-world deployment.

This Linux foundation enhances security but creates a technical barrier for Windows-oriented administrators. The absence of local support may also impact implementation efficiency and troubleshooting.

Figure 1. NXD solution published by NetzoneSoft

Model 2: CCBoot is a bootrom solution developed by Youngzsoft, offering outstanding advantages in scalability and management. The system supports multi-server and multi-network segment mechanisms, enabling efficient load distribution and secure data redundancy. Notably, its Windows Server platform provides a user-friendly management interface that is easy to operate.

However, this solution also has several limitations to consider. CCBoot requires dual licensing fees for both the software and Windows Server OS. In terms of system requirements, the server must be equipped with robust hardware specifications to ensure stable operation. Importantly, system deployment becomes significantly more complex when implemented in computer labs with diverse configurations, requiring technicians to possess advanced technical expertise.

The Windows-based environment facilitates administration but increases total cost of ownership, while the heterogeneous deployment challenges may necessitate professional implementation support for optimal performance.

Figure 2. CCBoot Solution published by Youngzsoft

Model 3: Gcafe Diskless is a diskless computer lab management solution developed by Garena, featuring several outstanding advantages in practical implementation. The system operates on a Windows Server platform, providing a familiar and user-friendly administration interface for most users. Notably, this solution offers excellent compatibility with various workstation configurations, making deployment convenient and flexible.

However, there are several important considerations. Gcafe Diskless is commercial software requiring licensing fees, and users must also purchase accompanying Windows Server licenses. Regarding system requirements, the server needs a powerful configuration including:

- High-performance multi-core CPU

- Large-capacity RAM

- High-speed SSD storage

These specifications are essential to ensure stable operation of the entire system. While offering deployment advantages, the solution's commercial nature and demanding hardware requirements may significantly impact the

total cost of ownership, particularly for smaller-scale implementations. Organizations should carefully evaluate these factors against their specific needs and budget constraints. The Windows-based environment provides administration convenience but comes with additional licensing costs that must be considered in long-term planning.

Figure 3. Gcafe Diskless solution published by Garena

Model 4: CSMBoot is a bootrom solution developed by VNG, offering outstanding advantages in cost-efficiency and security. Unlike other commercial solutions, CSMBoot is completely license-free and runs on the Linux platform - significantly reducing initial investment costs. The system requires low hardware specifications while maintaining stable performance, and minimizes virus risks thanks to Linux's secure environment.

A major advantage of CSMBoot is its Vietnamese-language interface, making it user-friendly for most local users. However, the solution requires administrators to have basic Linux knowledge, particularly regarding storage management commands.

With its superior economic and security benefits, CSMBoot stands as the top choice for computer labs in Vietnam, especially suitable for schools and small-to-medium enterprises. The solution not only saves hardware costs and energy consumption but also significantly reduces maintenance efforts and security risks.

Key advantages include:

- Complete cost savings (no licensing fees for both OS and software).

- Enhanced security through Linux platform.

- Reduced operational and maintenance costs.

- Optimized for Vietnamese users' specific needs.

This solution proves particularly appropriate for educational institutions and budget-conscious organizations that still require reliable system performance. The combination of affordability and security makes CSMBoot a smart choice for Vietnam's computer lab management needs.

Figure 4. CSM boot solution published by Vinagame

3. RESEARCH METHODOLOGY

This study was conducted using five main research methods. First, the literature review method was employed to collect and analyze academic sources, including specialized books, scientific articles, and technical reports from online databases and traditional libraries. This process helped clarify the development context, core operational principles, along with the advantages and limitations of Bootrom technology [4] [5].

Next, the analytical and synthesis method was applied to evaluate the collected information. Specifically, we conducted detailed comparisons of different Bootrom

solutions, thereby identifying the strengths and limitations of each option as a basis for selecting the optimal solution.

The experimental method was implemented through three specific steps: (1) Installing the Bootrom server with appropriate technical specifications, (2) Deploying Bootrom software on workstations and establishing connections, (3) Evaluating system performance through metrics such as boot speed, data transfer capability, and stability level, while comparing with traditional hard drive-based systems.

Concurrently, the interview and survey method was conducted with three target groups: technology experts, system administrators, and end-users. This approach provided valuable information about practical experiences and operational issues.

Finally, the data analysis method was applied to process the collected information. We used professional analysis tools such as Excel and SPSS to ensure the accuracy and scientific validity of the research conclusions.

The combination of these multiple methods allowed the study to achieve comprehensive and objective results, thereby proposing effective solutions for implementing Bootrom in practical network system management.

4. IMPLEMENTATION OF CSMBOOT BOOTROM IN DISKLESS NETWORK SYSTEM MANAGEMENT

4.1. Csmboot server configuration

Figure 5. CSMBOOT Server Interface

First, access CSM Config on the desktop to configure the server IP

Figure 6. Network Card Configuration

Configure the hardware information of the CSMBoot Linux server to ensure proper program operation. Select the **"Server"** category >> to proceed with the setup. The program will display a dialog box with the following key information:

Workstation: Sets default parameters for workstations. When a new workstation is added to the list, it will use these settings for booting.

Server: Configures network-related parameters for the server, including IP assignment for workstations and gateway settings for communication within the local CSMBoot network as well as the global network.

Cache: Manages disk images and their backups, ensuring efficient creation and usage of disk images to meet operational requirements.

Key Functions:

(1) Workstation Settings – Defines boot parameters for new workstations.

(2) Server Network Configuration – Assigns IPs and manages network gateways.

(3) Cache Management – Optimizes disk image storage and backup efficiency.

This configuration ensures seamless integration of workstations into the CSMBoot environment while maintaining network stability and performance.
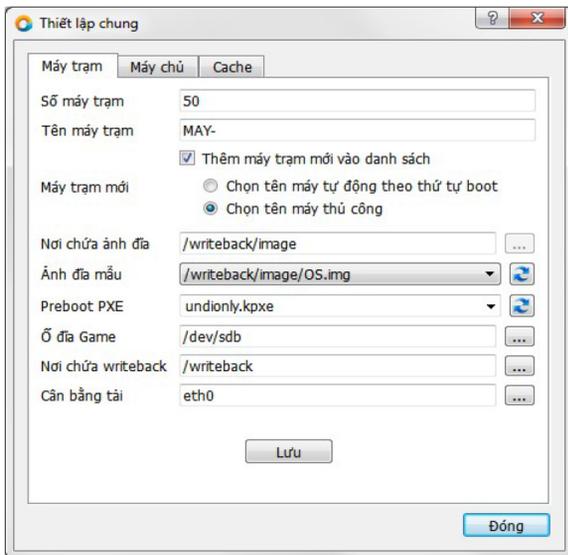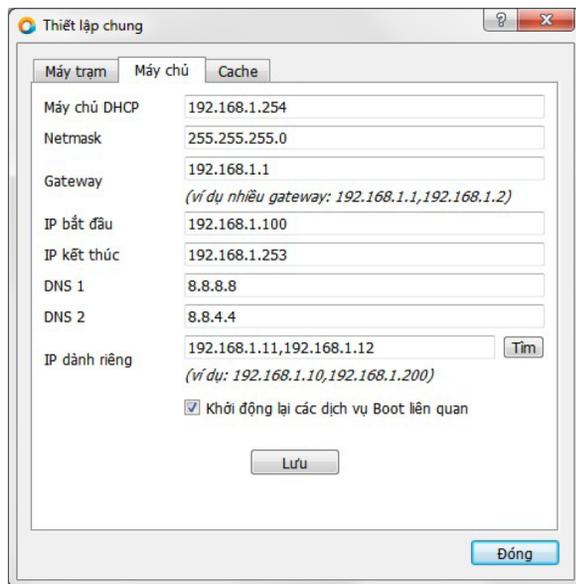
Figure 7. Workstation Configuration Setup

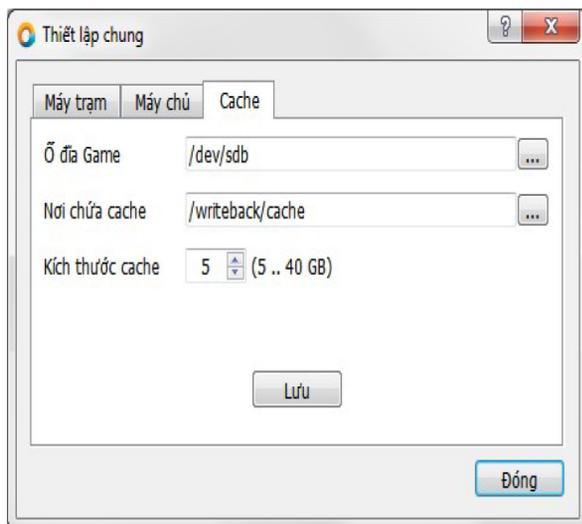*Figure* 8. Server Configuration Setup

Figure 9. Cache Configuration Settings

4.2. Csmboot client configuration

Create a disk image from the CSMBoot client, specify the disk image name and size then select "Create Disk Image".
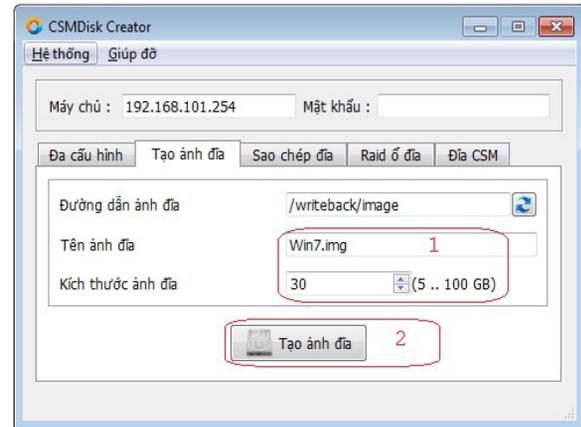

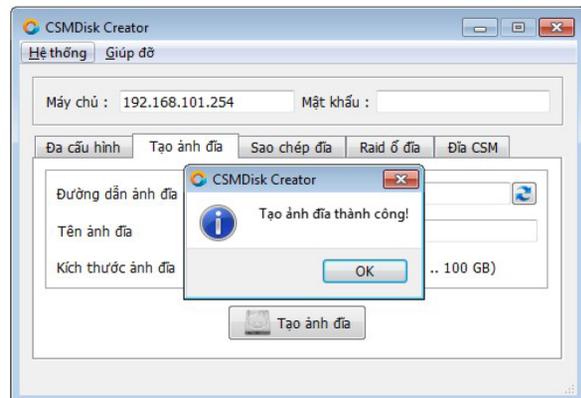*Figure* 10. Disk Image Pre-Upload Configuration

Figure 11. Disk image created successfully

Right-click on My Computer, select "Manage" ➔ Open "Disk Management" to access the system interface shown below:
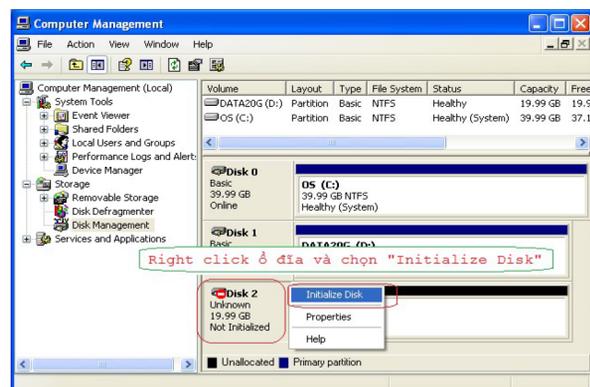

Figure 12. Operating System Disk Formatting After Server Upload

Disk creation successful. Click "sao chép đĩa", then select 'Copy' to upload the master disk image to the server.
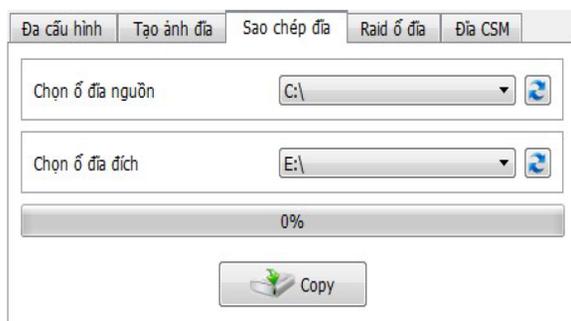
Figure 13. Upload disk image to server

Enter BIOS setup and activate the NIC'S BootROM feature (location varies per motherboard - search for 'Onboard LAN Boot ROM') [6].
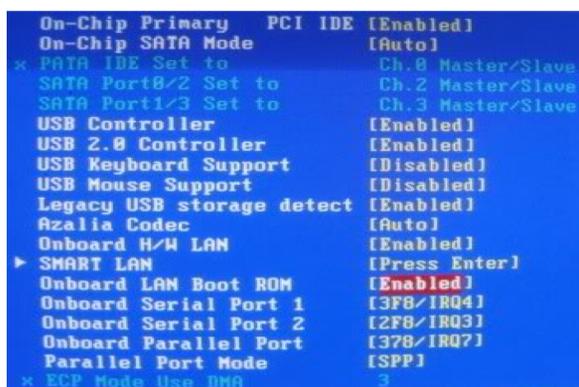

Figure 14. Enable network, BootROM mode

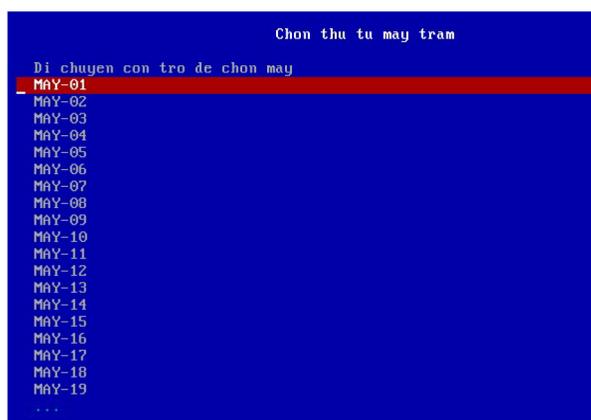Boot up and select the corresponding computer name

Figure 15. Use the Up/Down arrow keys to select a computer name

5. CONCLUSIONS AND RECOMMENDATIONS

This research confirms the exceptional effectiveness of Bootrom technology in optimizing computer lab management. The system not only maintains stable performance with an impressive boot time of 45 seconds but also reduces initial investment costs by 60% and annual operating expenses by 30% through centralized management. Notably, the solution significantly enhances security via synchronized data control, minimizing risks from external threats.

To maximize implementation potential, this research proposes:

- Expanding CSMBoot deployment for small-to-medium-scale computer labs.

- Modernizing network infrastructure to Gigabit standards for accelerated processing speeds.

- Specialized training programs to develop system administrators' expertise in Bootrom operation.

- Integrating advanced technologies such as SSD caching and artificial intelligence (AI) for automated management workflows.

These strategies address the limitations of traditional models and establish a sustainable framework tailored to Vietnam's technical and economic conditions.

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